RTU Main Control Unit DF1725IED-G

Product Guide

Cherishing the Environment
Saving Natural Resources

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2 Introduction

2.1 This manual

This manual provides product information on the SAS (Substation Automation System) Gateway product DF1725IED-G (later referred to as DF1725IED-G). It gives an overview of the product functionality, key benefits, application areas, technical details, and capacity and performance.

2.2 Use of symbols

This publication includes warning, caution and information symbols where appropriate to point out safety-related or other important information. It also includes tips to point out useful hints to the reader. The corresponding symbols should be interpreted as follows:

Warning icon indicates the presence of a hazard which could result in personal injury.

Caution icon indicates important information or a warning related to the concept discussed in the text. It might indicate the presence of a hazard, which could result in corruption of software or damage to equipment/property.

Information icon alerts the reader to relevant factors and conditions.

Tip icon indicates advice on, for example, how to design a project or how to use a certain function.

Although warning hazards are related to personal injury, and caution hazards are associated with equipment or property damage, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warnings and caution notices.

3 Functional overview

DF1725IED-G is a modular and scalable automation system that can be configured and tailored for various applications and needs. This chapter gives an overview of the main functionalities.

3.1 Configurable communication lines function

No protocol is bound to any communication line, this means three things: the 1st is, any protocol can use any communication lines; the 2nd is, running instance number of one same protocol is unlimited, provide that there are adequate communication lines; the last is, besides some special protocols, any protocol can use any type communication medias.

This characteristic brings most convenient for customers.

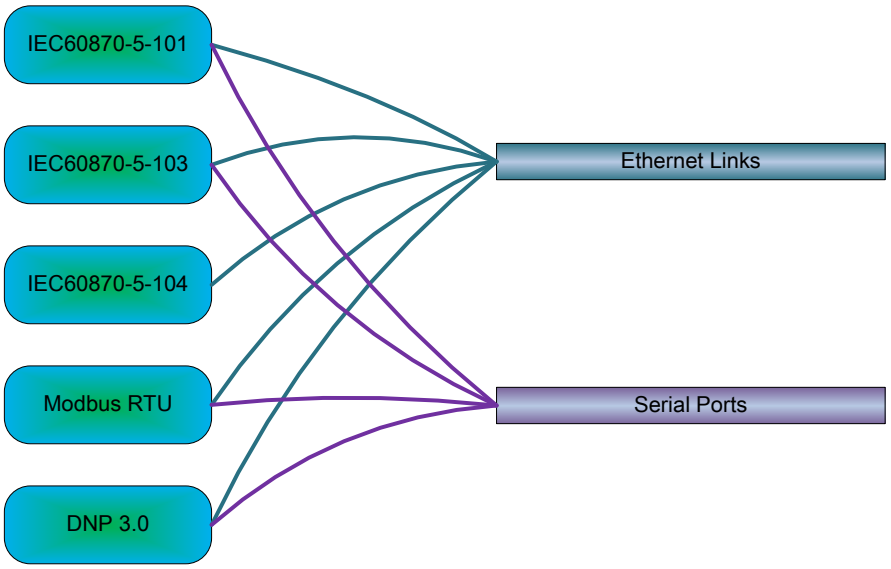

Figure 3.1: The coupling Relationship between Protocols and Communication lines

3.2 Process communication

The process communication is used to connect various process devices, such as IEDs, RTU I/O Modules, BCUs, PLC, and Meters to a DF1725IED-G. A large selection of communication protocols and interfaces, such as IEC 61850, IEC 60870-5-10x, DNP 3.0 and Modbus are supported. See Section 5.2.1 Communication protocols for the full list of supported protocols.

The process communication is used to retrieve data from the connected devices, such as status indications, events, and analog values, as well as to write data to the devices, such as commands, set points, and parameters. The data retrieved through the process communication can be archived, presented on the HMI, or forwarded to other systems.

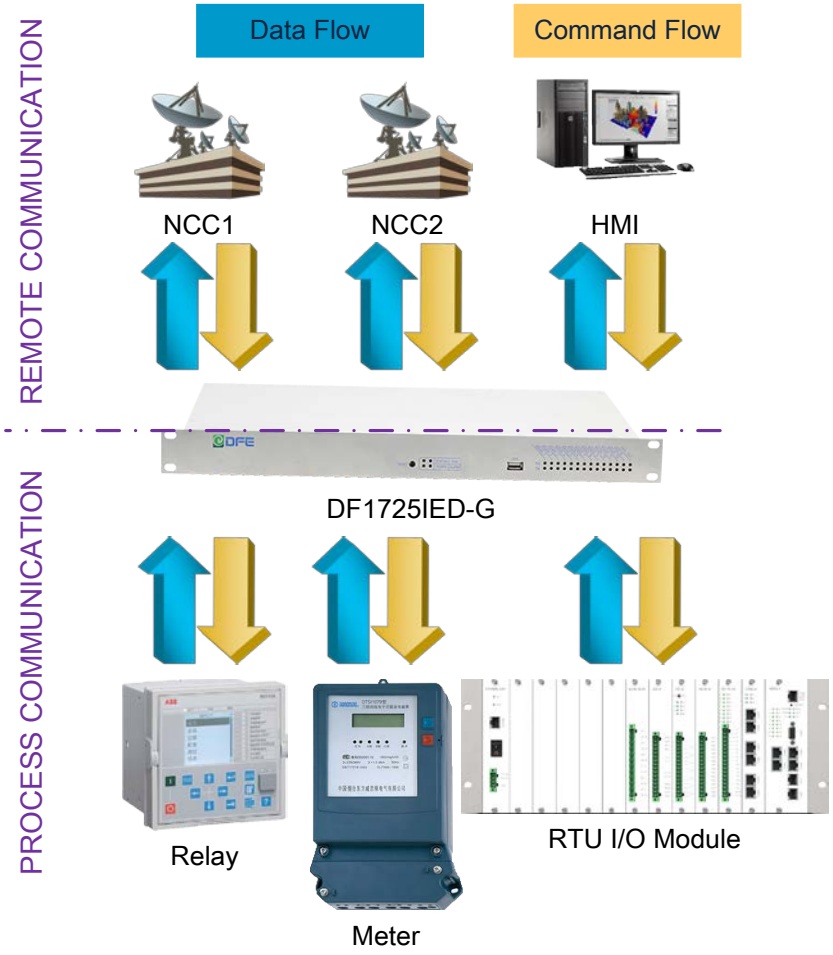

Figure 3.2: Process communication & Remote communication

3.3 Remote communication

The remote communication is used to connect a DF1725IED-G to upper level systems, such as Network Control Systems, Control Centers. The most common protocols, such as IEC 60870-5-101/104, DNP 3.0, are supported.

See Section 5.2.1 Communication protocols for the full list of supported protocols.

3.4 Communication gateway

The communication gateway functionality provides a gateway between process devices and upper level systems (NCC). The main tasks of the gateway are signal rerouting and protocol conversions. DF1725IED-G also supports signal grouping and possibility to introduce custom mapping logic in the gateway engine.

The following table lists the protocols that are supported by the gateway engine.

Table 3.1: Protocols supported by the gateway engine

Protocol	Type
IEC 60870-5-101	Master and slave
IEC 60870-5-103	Master
IEC 60870-5-104	Master and slave
IEC 61850-8	Client
DNP 3.0 (Subset 3)	Master and slave
Modbus	Master

3.5 Data buffering and distribution

All data that entered DF1725IED-G will be buffered into associated database. The buffer size for real time data is fixed, when new data come, the old data will be overwritten. While the buffers for events and alarm data were extendable, users can change the size of events buffer and alarm data buffer to meet their demands.

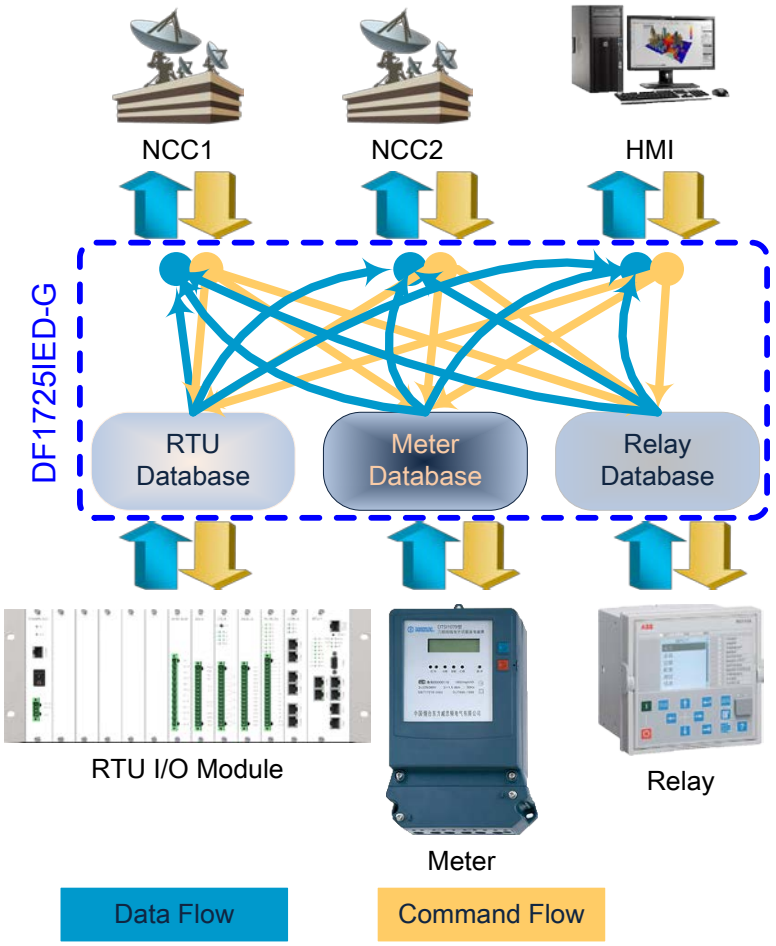

Figure 3.3: Data buffering and distribution

After buffering, all the data or part of the data can be transmitted to the upper level systems

(NCC), or the local mini SCADA systems (HMI). The transmitting sequence and data quantity are depended on your needs.

3.6 Programmable Logical Control (PLC)

The PLC function provides powerful means for data processing, logical functions building, conditional controlling and so on. For example, you can use this function to implement inter-lock control logic, or to implement a VQC function.

The programing language is compliant with IEC61131-3 standard. There are several programing languages for your selection, ladder, logical instruments, etc.

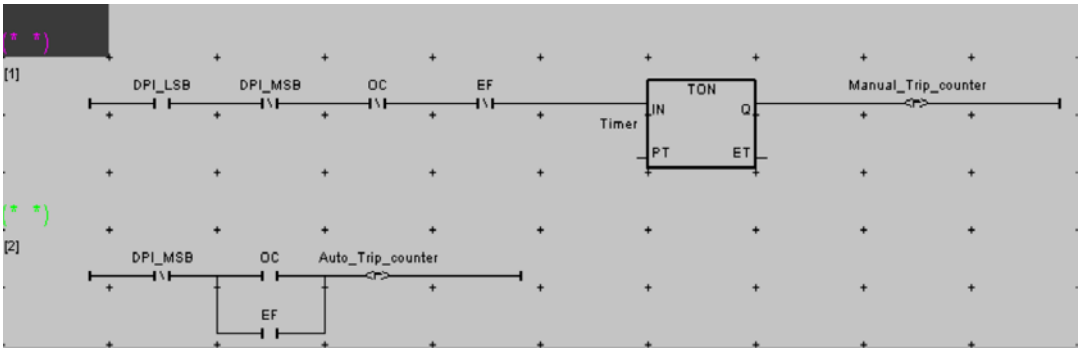

Figure 3.4: An example of PLC function programming

3.7 DF1725IED-G maintenance

3.7.1 Any Maintenance

DF1725IED-G can be connected to several maintenance clients as your demand at the same time. The maintenance clients provide means for the operator to configure the system and supervise and interact with the process. Each maintenance client can be a local one, or a remote one which connected through wired or wireless communication media, serial lines, Ethernet links, USB, or WIFI links.

The maintenance clients can be distributed over a network using TCP/IP. It can be a LAN, internet, or mobile wireless communication.

The maintenance can be used for engineering, supervision, and operation of the process. The possibilities are defined by the access rights given to the user in question. Also the layout and functions of the workplaces can be fully customized for each user.

The distributed maintenance concept is based on available remote access techniques, Any PC or other web-enabled device can be used as a workstation without installing any additional software.

3.7.2 System Self Supervision

The System Self Supervision function shows the status of the various system components in a display for easy and fast system maintenance and fault localization. The display shows information about the base system, applications, redundancy, communication lines, IEDs, and so on. The system can also receive status information from any device

reporting to the event log window.

3.7.3 Real Time Data Display

The Real time data Display shows all types data of the supervised device, analog input data, binary input data, counters… etc. The data will be refreshed and the rate of refreshing depends on the communication situation between the DF1725IED-G and the maintenance client.

You can also set the value of each point during data display. This function is very helpful in case of the project commissioning phase.

3.7.4 Events Display

With the Events Display you can monitor the information about events occurring in the system. Thus, you can make the right decisions and verify that taken measures have been successfully performed. You can also receive information about activities carried out by other users, operations of objects, acknowledging of alarms, editing of limit values, logging in, and all other type of events which can occur.

The Event Display presents the data in a structured way for the user's convenience. Each event is one row in the display. With default settings Event Display rows consist of a time stamp, object identification, a signal text and a text indicating the status.

3.8 Operation record / inquiry

The control output operation, analog output operation, etc. are very critical operations. Our system provides an operation recording function, when there is a demand to inquiry the operation process, you can retrieve it from the operation recording files.

3.9 Localization

It is possible to translate the user interface to any language, no matter the text size. The system also supports several languages enabling operators to work with the system in their native language.

3.10 Time synchronization

A DF1725IED-G can be synchronized by an external GPS clock. This is typically done using SNTP over the local area network or through a serial port using a protocol provided by the clock manufacturer (typically IRIG-B). DF1725IED-G can also be synchronized by the NCC over a remote communication protocol.

A DF1725IED-G can also be used as a clock master for the connected IEDs, either through the used protocol or through SNTP.

3.11 Redundancy

3.11.1 System redundancy

Two DF1725IED-Gs can be configured running in a hot stand-by mode (HSB). In this configuration, one DF1725IED-G is active and receives and processes all data from the process. At the same time, all process data and configuration data is shadowed over to the stand-by DF1725IED-G. The stand-by DF1725IED-G is in the same state as the active one. If the active DF1725IED-G breaks down, the stand-by DF1725IED-G takes over the process communication and continues to manage the process. In this way, the process can be operated and supervised even if one of the DF1725IED-G fails.

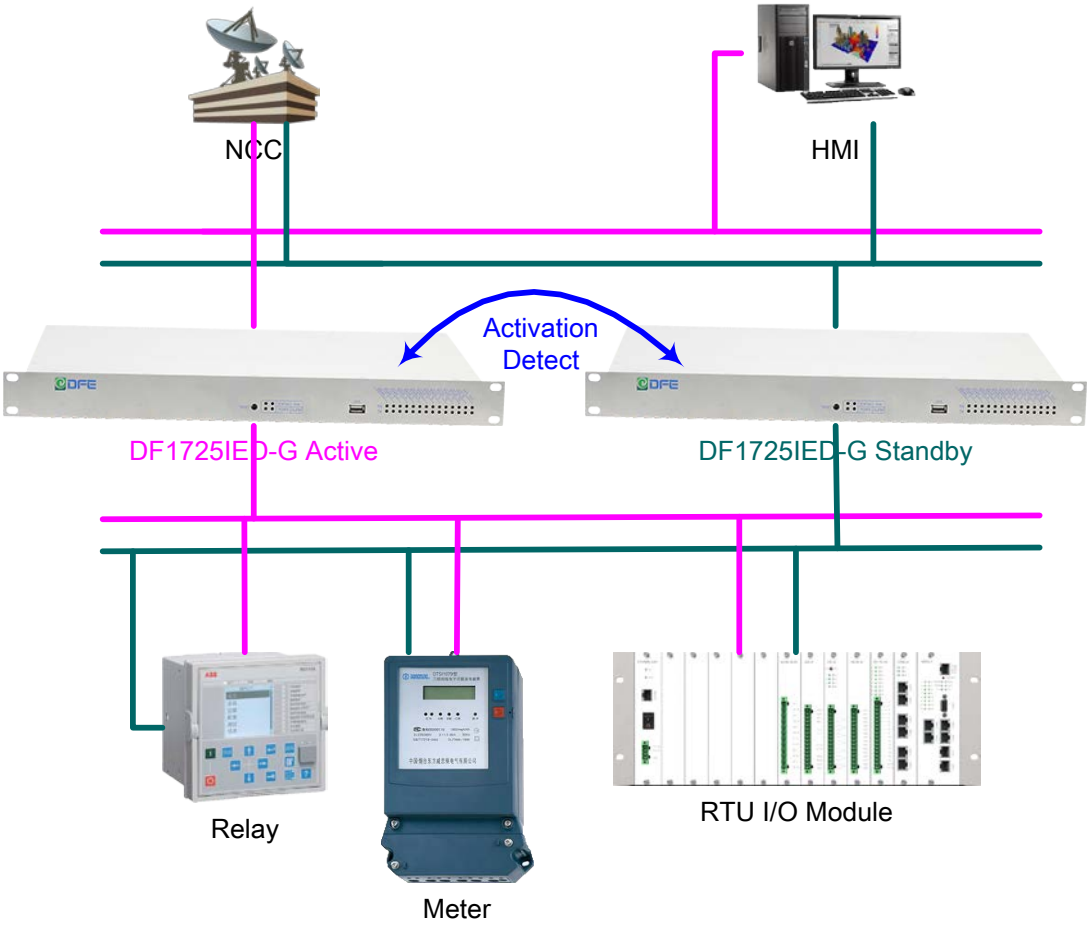

Figure 3.5: System redundancy, state 1,the couple DF1725IED-Gs are OK

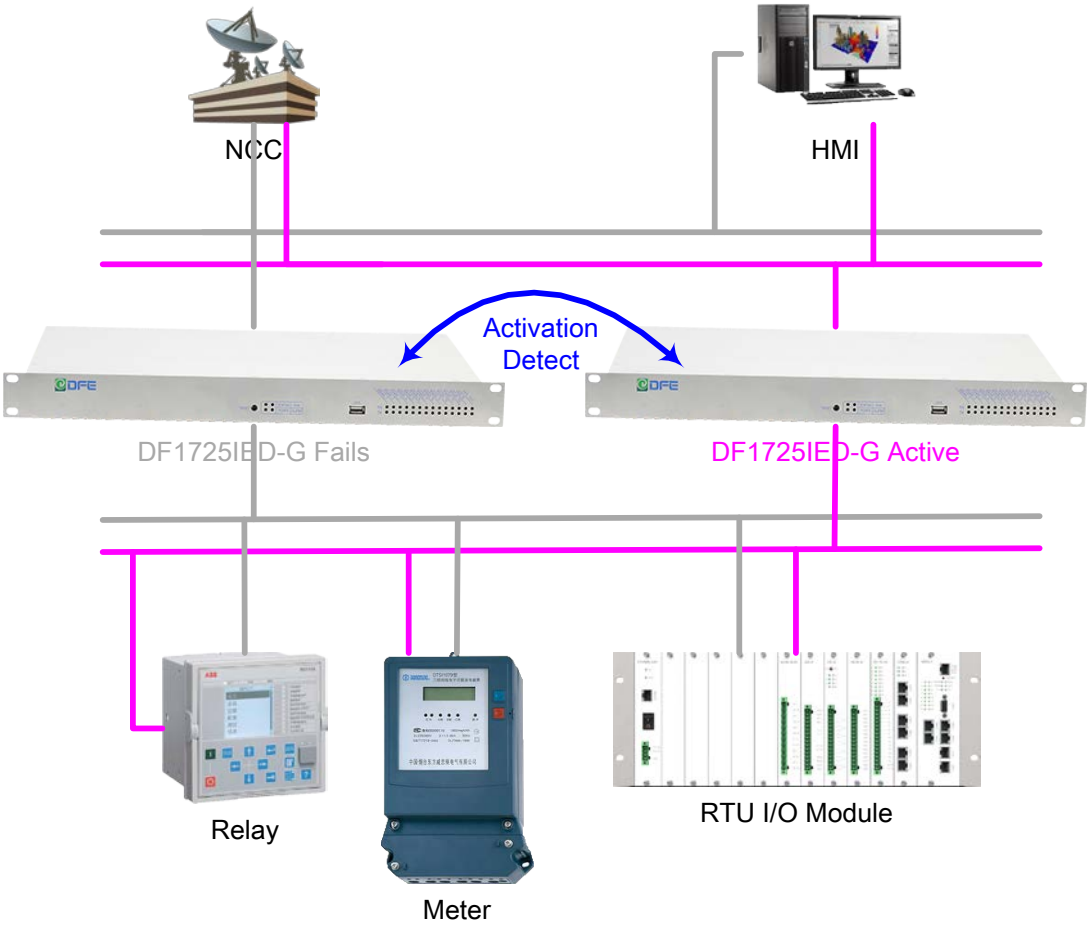

Figure 3.6: System redundancy, state 2, one DF1725IED-G fails

3.11.2 Communication redundancy

Redundant communication lines mean that two connections between the master and the slave form a logical connection. One of the connections is active and if the active connection fails, the other connection is used instead.

Redundant communication lines are supported for all protocols, For example, IEC60870-5-101/104, Modbus, DNP 3.0 LAN/Serial. No matter the protocol is master or slave.

Redundant LAN connections are supported for, for example, IEC 61850 communication using dual LAN connections according to IEC 62439/PRP.

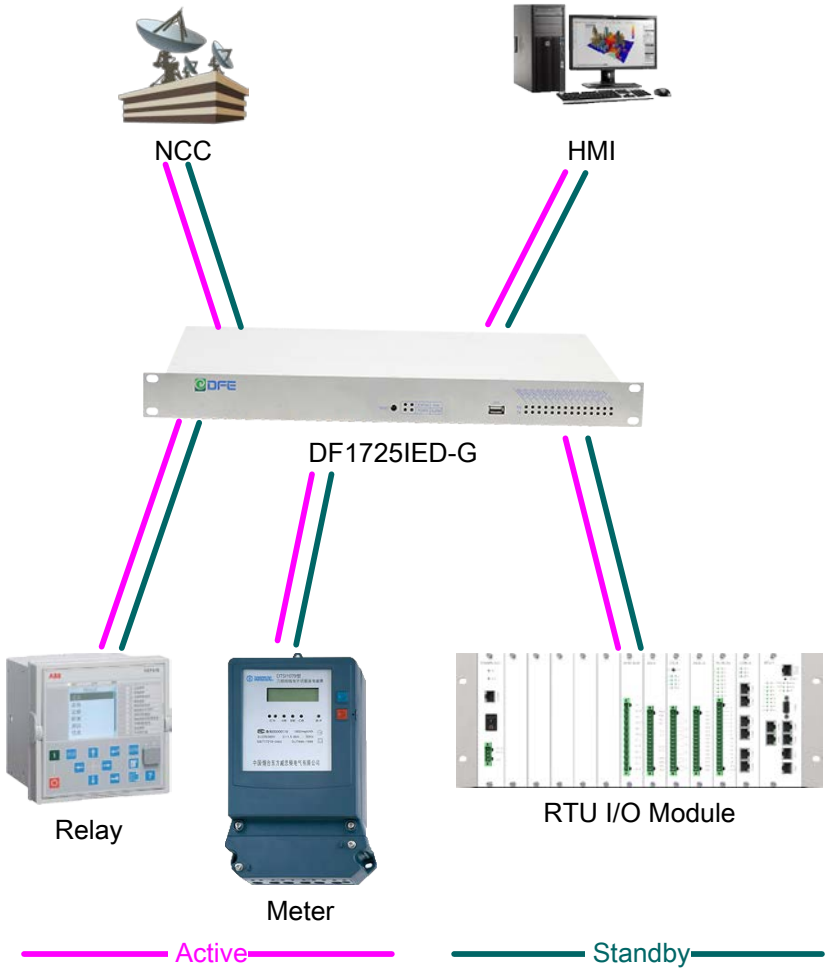

Figure 3.7: Communication redundancy, state 1, all communications are OK

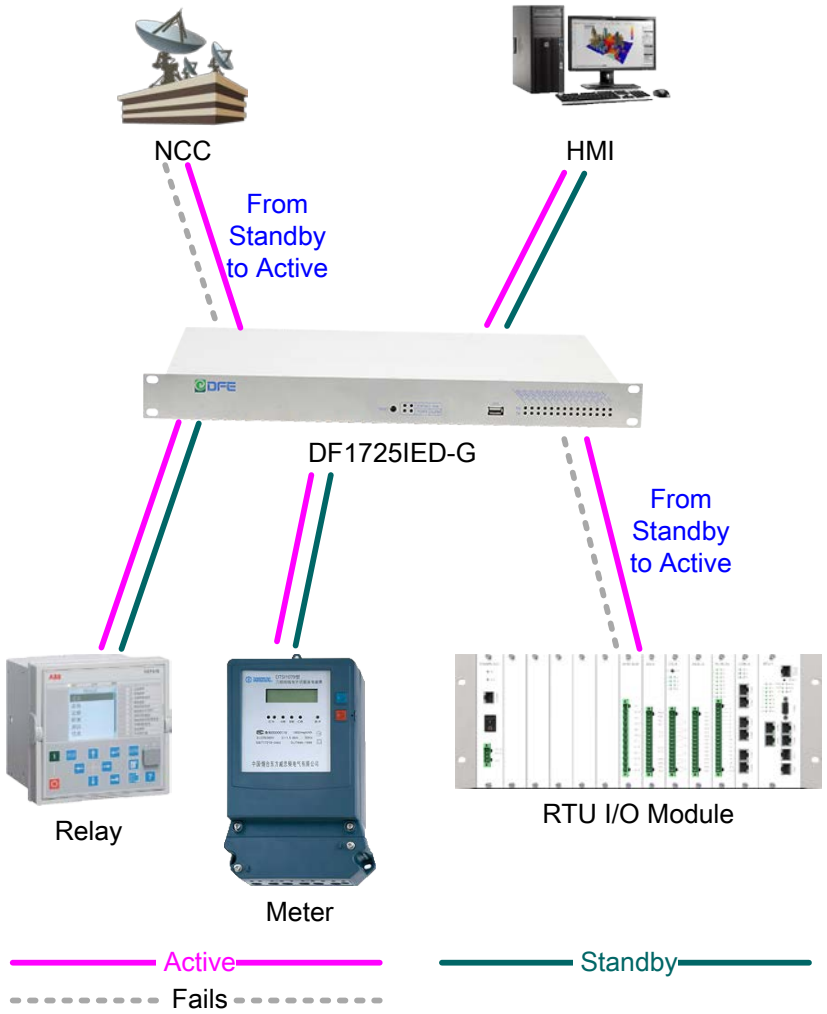

Figure 3.8: Communication redundancy, state 2, some communications switch to the peers

3.11.3 Full redundancy

Full redundancy means *System redundancy* **PLUS** *Communication redundancy*. Two DF1725IED-Gs are configured in a hot stand-by mode (HSB), each of them connects all the process devices and the upper systems (NCC). Regarding a certain process device or a NCC, at the beginning, the active DF1725IED-G tries to communicate with it, if fails, the system will try to use the hot standby DF1725IED-G to communicate with that process devices or the NCC, and this communication switch has no effect to any other devices. Under this case, the real-time data of that process device or the NCC will be shadowed over from the hot standby DF1725IED-G. After a while if the communication to the hot standby DF1725IED-G fails too, the system will try to use the active DF1725IED-G to communicate again.

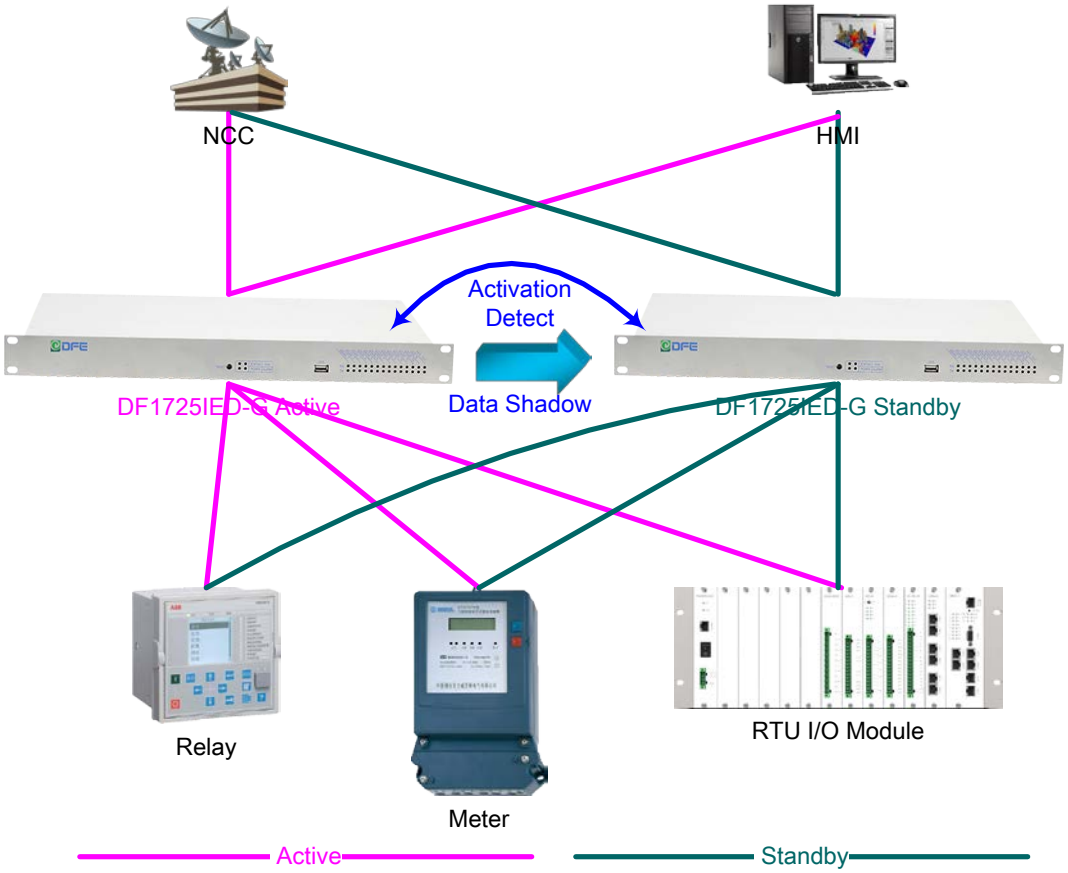

Figure 3.9: Full redundancy, state 1, all communications are OK

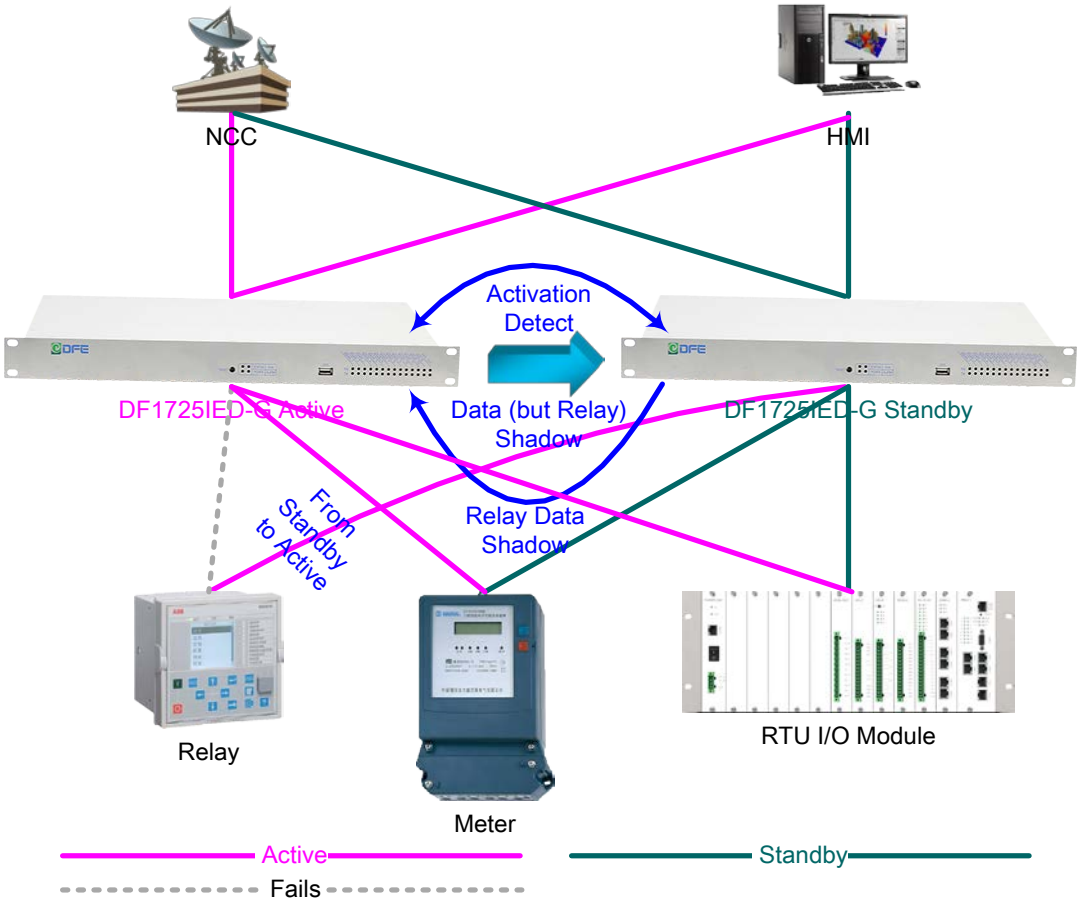

Figure 3.10: Full redundancy, state 2, a relay communication to the peer DF1725IED-G

3.12 Routing for Process Devices Maintenance

Suppose there is a substation, it is more than five hundred kilometers away from the control center where your office is located, and one of the relays has a parameter to modify, how do you deal with this work? Maybe there is no other way for you to choose but to drive a car to the substation and to modify the parameter of the relay. Now, provided you use a DF1725IED-G as the communication gateway, you can do the parameter modification work at your office with a cup of coffee. No need to suffer a long and hard journey.

The Maintenance routing function provides powerful means for maintenance process devices remotely, such as IEDs, RTU I/O Modules, BCUs, PLCs, and Meters, provided that the maintenance lines of process devices are connected to a DF1725IED-G, even if the IED is not a product of DFE.

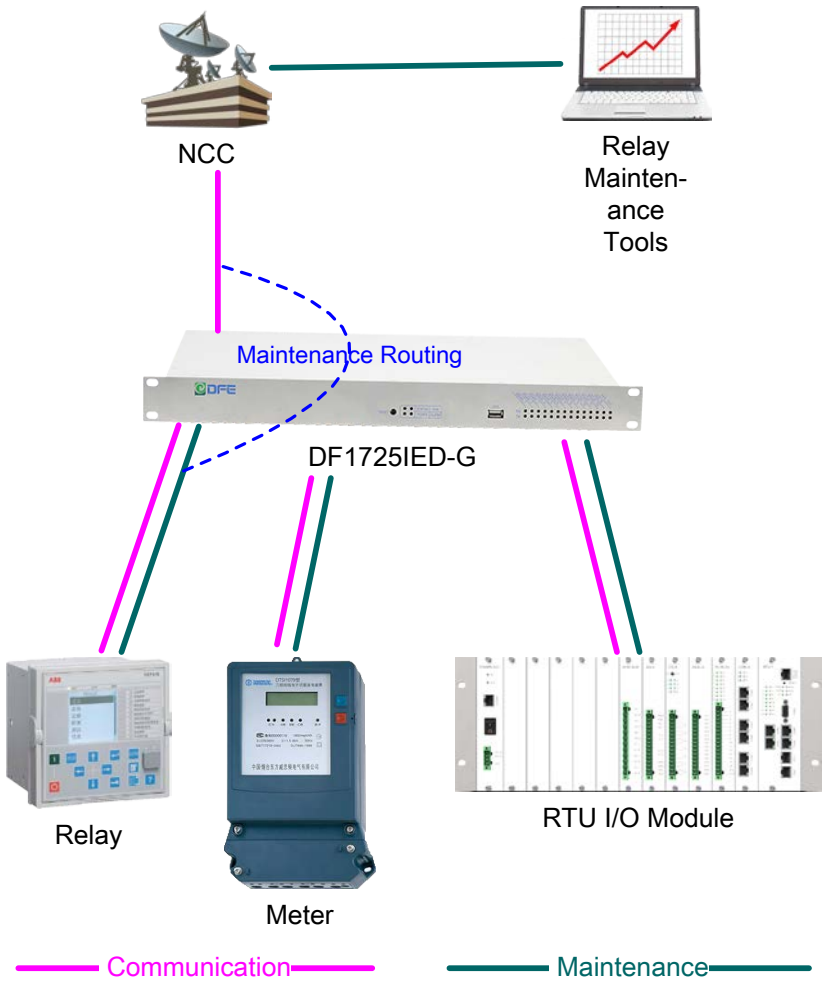

Figure 3.11: Routing for process devices maintenance

3.13 Key benefits

DF1725IED-G offers the following highlights and key benefits:

- Solid-state hardware technology
  - Enables use in harsh environments
  - Reduces maintenance needs
  - Support for wide operating temperature range
- High availability
  - Proven and tested hardware with high MTBF value
  - Support for redundant (Hot Stand-By) system servers
  - Support for redundant remote communication lines
  - Support for redundant power supplies for both AC and DC power supply
- Any Maintenance
  - Through ANY communication media
    serial lines, Ethernet lines, a Wi-Fi hotspot, a USB line
  - Got the IP address of a Ethernet line, you can maintain it;
    If not, you can maintain it too.
  - The specified maintenance communication port is health, you can

maintain it;
if not, you can maintain it too.
- Locally, you can maintain it ;
Remotely, you can maintain it too.
- You have a computer with the dedicated maintenance tools, you can maintain it;
If you just have a mobile only, you can maintain it too.
- Connecting to a DF1725IED-G, not only can maintain itself, but also the process IEDs those connected to it.

- Engineering efficiency
  - Integrated tools for system engineering, for example expansion of databases, communication system, HMI clients, and users
  - Easy to upgrade with latest software versions that enable use of new and innovative functionality
  - Routing for process devices maintenance, do all the process devices maintenance work in your office remotely, save your time, save your money and enjoy your work.
- Scalability
  - Enables system sizes ranging from tens to thousands of data points
  - Flexible system configuration
  - Conformance to a wide range of communication standards
  - Powerful hardware with large number of serial and Ethernet interfaces

4 Application areas

4.1 Overview

DF1725IED-G provides innovative solutions for different tasks and operations in the power automation process, from Communication Gateway functionality to full-fledged redundant control system applications. DF1725IED-G is a solid-state computer utilizing information distributed in different locations and hence enabled for a large variety of tasks. DF1725IED-G is suitable in, for example, Substation Automation Systems for both Utility and Traction applications, as well as in Process Industries with distributed Intelligent Electronic Devices (IEDs).

DF1725IED-G is designed as an open system, which complies with all widely used communication standards. In addition, it supports the implementation of project-specific monitoring, control, and automation tasks in the field of Substation Automation and Power Automation.

The consistent use of known technologies and intuitive user interfaces ensures an easy entry level for new DF1725IED-G users.

4.1.1 Fields of application

DF1725IED-G is designed to be used in a wide range of applications in both Electrical Utilities and Industries.

When using DF1725IED-G in substations, the main application is as a Communication Gateway to the upper level system. DF1725IED-G can be used in any type of substation.

DF1725IED-G fits also well into various types of control applications, especially where a solid-state type of computer is required and different kinds of distributed Intelligent Electronic Devices (IEDs) together with other type of bay devices (BCU) are to be connected to the system.

4.2 DF1725IED-G as Communication Gateway

DF1725IED-G is used for multiple purposes at a substation level. The Communication Gateway function is one of the tasks that can be utilized at the substation level to enable connections to Remote Control Centers (SCADA). DF1725IED-G Communication Gateway can connect to, and interact with, as many different Remote Control Centers as your demands.

The DF1725IED-G Communication Gateway function can be configured as a single gateway as shown in Figure 3.2.

For increased availability, DF1725IED-G can easily be configured as a redundant Communication Gateway as shown in Figure 3.7.

DF1725IED-G also supports redundant remote communication lines between DF1725IED-G and Remote Control Center as shown in Figure 3.7.

For increased availability, DF1725IED-G can be configured as a redundant Communication Gateway with redundant communication lines to Remote Control Center as shown in Figure 3.6 and Figure 3.9.

5 Product structure

5.1 Ordering, delivery, and life cycle policy

DF1725IED-G is a product that combines the robust hardware with the real-time operating system and the long-tested application software.

5.1.1 Hardware

The hardware exists in a number of fixed configurations that is selected during ordering. The fixed configurations concern the parts supplied by the DFE product unit. There are no options that can be ordered separately.

To replace the faulty DF1725IED-G hardware, customers with DF1725IED-G products can only order a DF1725IED-G spare hardware without the software license. If the DF1725IED-G hardware configuration needs to be changed for some reason, the only possibility is to order a spare hardware and replace the original one with the spare one.

5.1.2 Operating systems

The operating system is an embedded real-time operating system. It is integrated into one firmware together with the application software. The firmware can be upgraded after the delivery.

5.1.3 Application software

Our company has been concentrating on SAS system for more than 33 years. The application software can be extended or upgraded to new versions. New versions will be available for the DF1725IED-G hardware for at least 5 years after the hardware delivery. After that new application software versions may require an upgrade of the hardware.

5.1.4 Product identification

The DF1725IED-G product is identified by the hardware version and the software version.

Example: DF1725IED-G p1010-5.0, Hardware version p1010, software version: 5.0

5.2 Software options

5.2.1 Communication protocols

The following tables list the communication protocols of DF1725IED-G.

Table 5.1: Master protocols

Master protocol
IEC 61850-8-1 Client
IEC 60870-5-101, Single or redundant
IEC 60870-5-103, Single or redundant
IEC 60870-5-104, Single or redundant
DNP 3.0 LAN/WAN, Single or redundant
DNP 3.0 Serial, Single or redundant
Modbus RTU, Single or redundant
Modbus TCP/IP, Single or redundant
Customized master protocols, Single or redundant

Table 5.2: Slave protocols

Slave protocol
IEC 60870-5-101, Single or redundant
IEC 60870-5-104, Single or redundant
DNP 3.0 LAN/WAN, Single or redundant
DNP 3.0 Serial, Single or redundant
Modbus RTU, Single or redundant
Modbus TCP/IP, Single or redundant
Customized slave protocols, Single or redundant

5.2.2 System functions

The following tables list the DF1725IED-G system functions.

Table 5.4: System size parameters

System size parameters	Description	Value
Process I/O	Number of process objects connected to the process	1...150 000 Gateway functionality supports maximum 100 000 indications and 50 000 commands configured within DF1725IED-G.

Table 5.5: System options and interfaces

System option and interface	Description	Value
Control	This option enables control commands to be issued from the system. This option should normally be selected. This option can be left out in pure monitoring systems, where no output process objects are needed. You also need this option in gateway systems, if commands are propagated through the gateway.	Yes/No
Hot-Stand-By redundancy (HSB)	Select this option, if you have a redundant pair of DF1725IED-G using the Hot-Stand-By function.	Yes/No
Programmable Logical Control(PLC)	This option enables a universal logical arithmetic function, this is for data processing, logical functions building, conditional controlling and so on.	Yes/No

5.3 Hardware options

The DF1725IED-G hardware options are presented in the following tables.

Table 5.6: Hardware

Hardware
Power Supply: POWER-220V05S, 70 - 265 VAC / 88 - 350VDC (Single or redundant)
Power Supply: POWER-48V05S, 36 - 72 VDC (Single or redundant)
Power Supply: POWER-220V05S + POWER-48V05S
Ethernet ports: Option 1: 2 x RJ45 + 2 x LC (LC 1GB only) Option 2: 4 x RJ45 Option 3: 6 x RJ45 + 2 x LC (LC 1GB only) Option 4: 8 x RJ45
Storage device: No SSD (default), 64/128/256GB SSD (optional)

6 Hardware characteristics

6.1 Hardware

The following tables list the DF1725IED-G hardware specifications.

Table 6.1: Hardware specifications

CPU	Power PC P1010 800MHz
Memory	512MB DDR3
Storage device	4GB SATA (default), 32~64GB SSD (optional)
Serial ports	4 x RS232 + 12 x RS485
LAN ports	Option 1: 2 x RJ45 + 2 x ST (ST 1GB only) Option 2: 4 x RJ45 Option 3: 6 x RJ45 + 2 x ST (ST 1GB only) Option 4: 8 x RJ45
USB 2.0	1 x USB
Power supply	70 - 265 VAC / 88 - 350VDC 36 - 72 VDC AC Power supply frequency range is 47-63Hz Redundant power supply is optional
Power consumption	30W max.
Heat production	30W max.
Temperature	Operating: -40°C ~ +70°C Storage: -55°C ~ +80°C
MTBF	25 years (+25°C / 77°F) 22 years (+40°C / 104°F)
Relative humidity	5% ~ 95% (+40°C / 104°F) non-condensing
Protection class	IP40

6.2 EMI/EMS and environmental standard compliance

The following tables list the EMI/EMS and environmental standard compliance.

Table 6.2: IEC 61850-3 standard compliance

Type test	Description	Severity level
IEC 61000-4-2-2001	Electrostatic Discharge	Level 4 -±8KV Contact/±15KV Air
IEC 61000-4-3-2006	Radiated RF Succeptibility	Level 3-18V/m, 6 directions
IEC 61000-4-4-2004	Fast Transient (Burst Immunity)	Level 4- ±4KV 5KHz
IEC 61000-4-5-2005	Surge Immunity	Level 4 ±4KV line-to-earth/±2KV line-to-line
IEC 61000-4-6-2006	Conducted RF Immunity	Level 3-10Vrms
IEC 61000-4-8-2001	Magnetic Field Immunity	Level 5- 100A/m 5min / 1000A/m 1s
IEC 61000-4-10-1993	Damped Magnetic Immunity	Level 4- 30A/m
IEC 61000-4-12-1995	Damped Oscillatory Burst	Level 3-2.5KV common/Differential 1.25KV for Substation
IEC 61000-4-16-2002	Conducted RF Immunity	Level 3-15Hz~150KHz
IEC 61000-4-29-2000	Voltage Dips and Interrupts	30% 120ms/ 70% 10ms 100% 3ms (cycle 3)
CISPR22-2008	Conducted and Radiated Emissions	Class A
FCC 15	Conducted and Radiated Emissions	Class A
EN55022A	Conducted and Radiated Emissions	Class A
IEC 60255-5	Insulation resistance measurement	500VDC, 1min, 999Mohm>100Mohm
IEC 60255-27	Protective bonding resistance	25Amps, 1min, 0.021ohm<0.1ohm

Table 6.3: IEEE Std 1613-2003 standard compliance

Type test	Description	Severity level
IEEE C37.90.1	EFT	Level 4- ±4KV 5KHz All ports
IEEE C37.90.3	ESD	Level 4 -±8KV Contact/±15KV Air
IEEE C37.90.1	Oscillatory Wave	Level 3-2.5KV common/Differential 1.25KV for Substation
IEEE C37.90	Dielectric Strength	2000Vrms
IEEE C37.90	Impulse Voltage	5000V
IEC 60870-2-1-1995	DC Voltage Ranges	-20%~+15%
IEC 60870-2-1-1995	Voltage Ripple of DC	Level VR3- ≤5%
IEEE C37.90	Nonoperational Temperature Range	-40°C~+75°C
IEEE C37.90	Operational Temperature Range	-30°C (Start Up)~+65°C

Table 6.4: Environmental standard compliance

Type test	Description	Severity level
IEC 60068-2-1	Cold Temperature	-30°C Start Up for 16 hours
IEC 60068-2-2	Dry Heat Temperature	+65°C Start Up for 16 hours
IEC 60068-2-30	Humidity (Damp heat, Cyclic)	Test Db 6 cycles +25°C/+55°C 93%/95% (1 cycle=24hrs)
IEC 60068-2-3	Humidity (Damp heat, Steady state)	95% (non-condensing) 40°C 2d
IEC 60870-2-2-1996	Vibration	10-200-500-200-10Hz (1g/1.5g) X/Y/Z axes
IEC 60870-2-2-1996	Shock	10g 11ms X/Y/X axes
IEC 60068-2-29-1987	Bump (Packed)	10g, repeat 1000 times X/Y/Z axes
IEC 60068-2-29-1987	Bump (Unpacked)	10g, repeat 1000 times X/Y/Z axes

7 Capacity and performance

7.1 DF1725IED-G capacity

This chapter gives an overview of the capacity of DF1725IED-G regarding the following functions or aspects:

- Number of IEDs that can be connected
- Usage of the following functions: gateway, HSB
- Data logging and event logging

The system size capacity figures follow these principles:

- A guideline for the maximum process communication (Number of IEDs or Number of Messages/sec.) is given. This includes the process communication functions and the logging of data in the process database.
- If other functions are added, such as PLC, HSB, maintenance routing, internal calculation, they consume system capacity and thereby the process communication capacity must be reduced accordingly. For IEC 61850 the capacity is mainly affecting the number of messages, and thus it is more important that this is reduced than the number of IEDs.
- The impact on the process communication capacity of the other functions is given in percentage.

Example: How many IEDs can be connected over IEC 61850 to DF1725IED-G that acts as a gateway with one NCC connection and one operator workplace?

- Maximum of 160 IEDs can be connected over IEC 61850 (with 12 msg/s/IED), see Table 7.1.
- The following functions are also needed:
  - One NCC connection (-5%)
  - HSB (-5%)
  - PLC (-5%)
  - The process communication capacity in this case is:
    - 95% * 95% * 95% * 160 IEDs = 137 IEDs or
    - 95% * 95% * 95% * 1920 msg/s = 1646 msg/s

7.2 Process communication capacity

The capacity of one protocol means that only that protocol is used. If several protocols are combined, the maximum capacity per protocol must be reduced proportionally.

Example: IEC 61850 and DNP 3.0 are combined in the system. The IEC 61850 IEDs represent 60% of the maximum IEC 61850 capacity. Then the actual maximum DNP 3.0 capacity is 40% of the indicated maximum capacity.

The following tables show the maximum communication capacity for the most commonly used protocols.

Table 7.1: Maximum communication capacity

IEC 61850	**Value**	**Comments**
Num of messages	1920/s	
Num of IEDs	160	
Num of IEC 61850 clients	4	
IEC 103		
Num of IEDs	200	
Num of IEDs / line	15	Limited mostly by maximum response time
IEC 101		
Num of IEDs	200	
Num of IEDs / line	15	Limited mostly by maximum response time
IEC 104		
Num of IEDs	200	If I/O count is small, number of IEDs can be bigger
Num of IEDs / line	15	
Modbus RTU		
Num of IEDs	200	
Num of IEDs / line	15	Limited mostly by maximum response time
Modbus TCP/IP		
Num of IEDs	200	
Num of IEDs / line	15	Limited mostly by maximum response time
DNP serial		
Num of IEDs	200	
Num of IEDs / line	15	Limited mostly by maximum response time
DNP LAN		
Num of IEDs	200	If I/O count is small, number of IEDs can be bigger
Num of IEDs / line	15	

Table 7.2: Impact on process communication

Function	**Impact on process communication**	**Comments**
Local process database	- 0%	Always included
Hot Stand-by redundancy	- 5%	
Gateway / NCC connections	- 5%	
Programmable Logical Control	- 5%	

The following list shows some examples when IEDs are connected to DF1725IED-G with the following Gateway or NCC connections and with Local process database:

- NCC connection with one DNP LAN communication including 84 IEDs resulting in 1 000 process updates per second sent to one NCC*)
- NCC connection with two DNP LAN communications including 67 IEDs resulting in 1 600 process updates per second sent to two NCCs*)
- NCC connection with one IEC 104 LAN communication including 158 IEDs resulting in 1 900 process updates per second sent to one NCC
- NCC connection with two IEC 104 LAN communications including 116 IEDs resulting in 2 800 process updates per second sent to two NCCs
- NCC connection with one IEC 61850 protocol client communication including 60 IEDs resulting in 720 process updates per second sent to one NCC*)
- NCC connection with one IEC 61850 protocol client communication including 63 IEDs resulting in 1 500 process updates per second sent to two NCCs*)
- NCC connection with one IEC 61850 protocol client communication including 83 IEDs resulting in 1 000 process updates per second sent to one NCC*)

*) 90% 16-bit analog data without time, 5% binary data without time and 5% binary data with time

8 Abbreviations

Abbreviation	Description
DFE	Donfang Electronics Co. Ltd
EMI	Electromagnetic Interference
EMS	Electromagnetic Shielding
HMI	Human System Interface
IED	Intelligent Electronic Device
IP	Internet Protocol
LAN	Local Area Network
LED	Light Emitting Diode
MTBF	Mean Time Between Failure
NCC	Network Control Center
OPC	OLE for Process Control
PLC	Programmable Logic Controller
RTU	Remote Terminal Unit
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol
SSD	Solid State Drive
DF1725IED-G	Product name
USB	Universal Serial Bus
VPN	Virtual Private Network
VQC	Voltage Quality Control

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